Topology Control Algorithms for Spacecraft Formation Flying Networks Under Connectivity and Time-Delay Constraints, Phase I

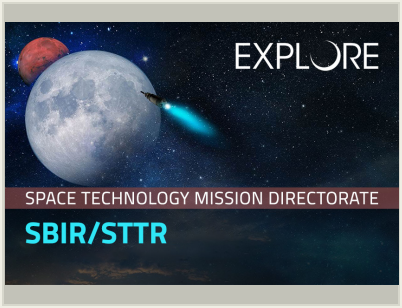
Completed Technology Project (2009 - 2009)

Project Introduction

SSCI is proposing to develop a set of topology control algorithms for a formation flying spacecraft that can be used to design and evaluate candidate formation architectures. Properties of these topology control algorithms include: (a) Preserving the connectivity of the underlying state-dependent sensing graph during reconfiguration and re-targeting of the formation; (b) Achieving a balanced interplay between performance and robustness to communication delays; and (c) Using only local information to make local decisions that collectively guarantee the global properties such as the network connectivity. Phase I effort will deliver a preliminary software analysis tool to help the NASA TPFI team evaluate these trade-offs for candidate TPFI architectures. In order to achieve these objectives we plan to carry out the following tasks: (i) Develop algorithms to maximize the connectivity under limited FOV constraints. (ii) Analyze the trade-off between network connectivity and robustness to communication delays. (iii) Design algorithms to maintain connectivity during a pre-specified reconfiguration with energy optimal trajectories. (iv) Demonstrate the application of the developed methods to TPF-I baseline mission. In Phase II the goal is to deliver to NASA a complete set of algorithms and software tools to perform distributed communication design for TPF-I as well as other formation flying missions that may involve a larger number of spacecraft. These algorithms and software will be tested on high fidelity formation flying testbeds at JPL such as FAST or FCT.Professor Mehran Mesabhi of University of Washington will provide technical support under the project.

Anticipated Benefits

Among non-NASA applications are several current ongoing projects by the military. Department of Defense agencies, including DARPA, are focused on developing the next generation of collaborating and formation flying Unmanned Vehicles (UAVs, USVs, UUVs etc.) which can use the analysis methods and tools developed under this effort for performing trade-off studies for designing distributed multi-agent networks.



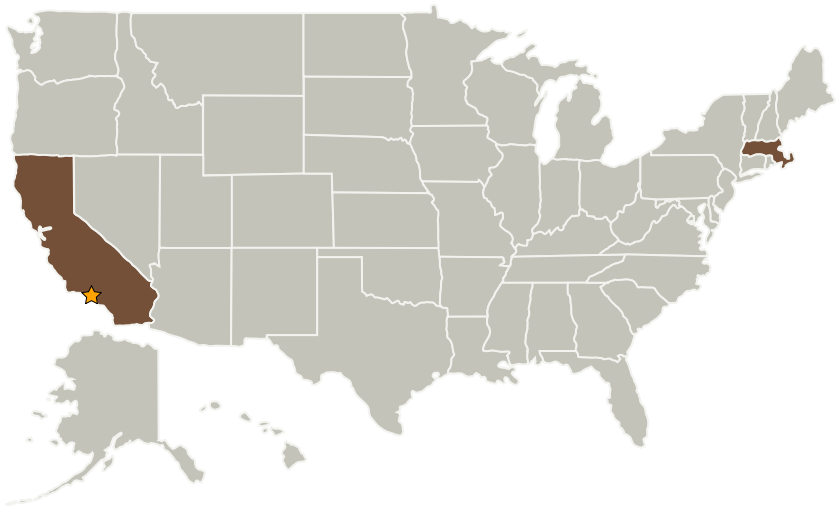
Topology Control Algorithms for Spacecraft Formation Flying Networks Under Connectivity and Time-Delay Constraints, Phase I

Table of Contents

Topology Control Algorithms for Spacecraft Formation Flying Networks Under Connectivity and Time-Delay Constraints, Phase I

Completed Technology Project (2009 - 2009)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
Scientific Systems Company, Inc.	Supporting Organization	Industry Small Disadvantaged Business (SDB)	Woburn, Massachusetts

Primary U.S. Work Locations	
California	Massachusetts

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Manager:

Celestino Jun Rosca

Principal Investigator:

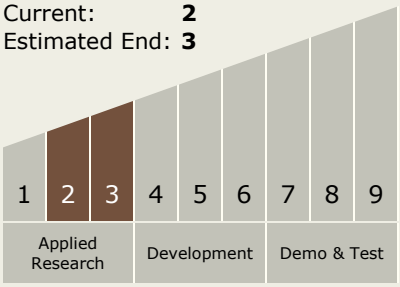
Jovan Boskovic

Topology Control Algorithms for Spacecraft Formation Flying Networks Under Connectivity and Time-Delay Constraints, Phase I

Completed Technology Project (2009 - 2009)

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.3 Control Technologies
    - TX17.3.1 Onboard Maneuvering / Pointing / Stabilization / Flight Control Algorithms